

BOOKS AND LIBRARIES IN THE SCIENTIFIC AGE

(Talk given by Harold Wooster, Director of Information Sciences, Air Force Office of Scientific Research, Office of Aerospace Research, United States Air Force, Arlington, Virginia 22209, in the Sarah Lawrence College-Westchester Library Association Lectureship, "Books, Man and Society", 9 January 1967)

It takes chutzpeh for a non-librarian--a card-carrying, fine-paying denizen of the outer darkness beyond the pale of the circulation desk--to talk about libraries in the intellectual company of such distinguished practitioners of that branch of higher gamesmanship, called librarianship, as Professor Broderick, Recidivist-Dean Shaw, and Librarian Orne. But for a scientist to claim this as an age of science takes not chutzpeh but hubris.

It is much easier to do science than to define it in terms both acceptable to the scientist and intelligible to the non-scientist. One good definition (by A. S. Iberall in Report No. 2 "Annotated Interdisciplinary Bibliography of the Physical Sciences" prepared by General Technical Services, Inc. for the Army Research Office under Contract DA-49-092-ARO-114, July, 1956) of science is "the long chain of logical argument that is required to relate structure and function in a limited portion of the real world with verbal-symbolic description that is capable of predictive extrapolation beyond the limited observations from which it is drawn" but, unfortunately, this does little more to help me to explain why this is a scientific age than does E.P. Hoyt's definition (or, more properly,

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the definition used on the dust jacket of Vol II of his "A Short History of Science", John Day, N.Y. 1964 or 1966, depending upon whether you believe the LC card number of the date of the author's copyright) of science as "the use of man's intelligence in the solution of his problems." Not, at least, on my good days, when I think man's intelligence and the problems it creates are coming out even.

As Warren Weaver has said (in Goals for Americans, Alfred P. Sloan Foundation, New York, 1961): "Pure science is not technology, it is not gadgetry, it is not some mysterious cult. Science is an adventure of the human spirit; it is an essentially artistic enterprise, stimulated largely by curiosity, served largely by disciplined imagination, and based largely on faith in the reasonableness, order and beauty of the universe of which man is a part."

But science is just one of the adventures of the human spirit, just one form of artistic-intellectual enterprise. It would be difficult for me to argue that our particular form of intellectual activity sets the tone for this society as, for instance, four centuries of explorers and exploration did for our ancestors. Only a handful of the population went, or wanted to go on these expeditions, but the feeling that there was something lost behind the ranges, that it only took bravery, and courage, and stubborn plodding to fill in the vast empty spaces on the maps, that this planet had unlimited room

and unlimited resources waiting only to be found created a frontier feeling we no longer have.

Science too is a frontier activity, and most people are neither capable nor desirous of living at the frontiers, intellectual or physical. We are perfectly willing to settle for second-hand accounts of explorations. Writing books is still a standard method of financing all forms of physical, and some forms of intellectual expeditions. The historians have learned that it is spectacularly more profitable to publish second-hand accounts of historical investigations as trade books rather than first-hand accounts in little professional journals. With the possible exception of a Dean who writes a comic strip, a Nobel Laureate who writes a newspaper column, a few astronomers and anthropologists and, of course, Gamassimov most scientists have left their second hand business to science writers.

It would certainly be difficult to characterize this as an age of science on the basis of comparative sales of books about science and books about the Civil War.

Science involves many interactions between the intellectual and the physical world, but the enclaves which science has achieved for itself are fairly remote from our daily lives, even if their consequences are not: the stewardship of certain, highly specialized physical systems, such as atomic and nuclear physics, molecular biology and ultimate weapons; medical problems, especially if more complex than the stethoscope and the scalpel--the application of all other sciences to medicine,

such as biomedical engineering, building artificial body organs, such as kidneys and hearts; abstract modelling, especially if exotic, such as computerization and automation; certain rarefied forms of engineering, such as space technology and weapons systems, and; the primordial beginnings of something presumptuously called management engineering.

When man was thinly scattered on the face of this planet he could hunt, and move on as the game was exhausted; he could farm and bleed the soil and move on to new unplundered fields; he could foul his camp-sites like the Bandar-log and move on. But, as the frontiers vanished, so too did the options. And, as society coalesced into villages, into towns, into cities, into metropolises, into the megalopolises that are and the Megalopolis to be, its dependence upon technology increased.

Science has opened up entirely new realms of technology which would have been completely beyond the reach of those who followed the traditional lines of the past based on everyday reasoning and the lore of the artisan, regardless of how well such a pattern served our species over many thousands of years--technology based, for instance, on chemistry, on electricity and magnetism, on the universe of atomic phenomena.

It is not science but its applications through technology that so intimately affect our daily lives: the food we eat; the clothes we wear;

our shelter; our personal physiological habits (did you take your vitamin pills this morning?); our personal well-being; our mobility; our ecological milieu--we now wholesale what the Bandar-log retailed, and; our national defense.

And science differs from all other forms of intellectual activity in one important respect. Most of us, at best, can live at only one narrow segment of the intellectual frontier. We know of other frontiers by second hand accounts or derivative products. There were, briefly Mondrian and even briefer op-art dresses; Campbell seems to have redesigned their soup cans to look like Andy Warhol paintings; the twelve-tone scale, via the Indian raga, is creeping into folk-rock. So what?

It is possible to avoid the consequences of second-rate culture. You can always steal the batteries out of your childrens' transistors and the needles out of their record-players, and forget to have the TV repaired; you don't have to read non-book ;; there is a certain sparse elegance to bare white walls. But you cannot avoid the consequences of second-rate science. A bridge designed without consideration of aerodynamic stability can, literally, shake itself to pieces. Life insurance companies that based their rate structures on poorly computed actuarial tables went bankrupt. Inadequate understanding of the dynamics of electrical networks can black out large sections of the country. The lessons of that particular form of analog

computer known as the wind tunnel must be understood most thoroughly indeed by the aircraft manufacturer who wishes to avoid headlines on either the financial or the front pages of the daily paper.

So, to the extent that we could not live as we do without technology, and that technology in turn could not live without science; that science therefore is the form of intellectual activity which most intimately, even though indirectly affects not only our daily lives but our personal survival this is indeed, whether we like it or not, an age of science.

Intellectual activities, at least in the foreseeable future, must be carried out by people. What sort of people are scientists? There are at least two sorts of usual answers to this question. One is the superman answer, beloved of school teachers. Scientists are supermen, like Galileo (but not Copernicus and Tycho Brahe whose ideas Galileo, to put it politely, popularized) and Newton and Wernher von Braun. The superman theory, plus a certain amount of perfectly natural mythopoiesis, is probably responsible for a number of stale misconceptions about scientists. The last scientist-hero of a novel by a major American author (thus excluding both C.P. Snow and Mitchell Wilson) was Martin Arrowsmith in 1925 - perhaps because Paul de Kruif helped Lewis write this book. The last scientist-heroine of a major Hollywood film producer was Greer Garson as Marie Sklodowska.

And certainly the last scientist to be both accepted by his peers

and become an American folk-hero was Albert Einstein. Nobody outside the trade actually knew what he had done. This didn't matter, because only 12 men in the world were supposed to be able to understand relativity, but everybody knew that he didn't go to the barber as often as he should, that he played the violin, that he had trouble remembering his address and that he didn't always get the right answers when he did arithmetic homework for the little girl next door. A real scientist, brilliant and unworldly. (Yet it was the pacifist refugee Einstein, more than any other man, whose letter to President Roosevelt started the long chain of U.S. research and development which gave us first the Manhattan Project and then the atomic bomb!)

But, since it's hard to think of the 500,000 scientists at work in the United States today as so many Einsteins, or even superman (they tend to look more like Clark Kent) there's also the "just plain folks" theory. As Aldous Huxley wrote in his last book, "Literature and Science":

"Let us face facts. A large number of young people take up research as a career these days, but regrettably few are impelled into it by a passionate curiosity as to the secrets of nature. For the vast majority it is a job like any other job...Moreover, it is not generally realized outside of academic circles how far a mediocre research worker can get. With the exception of pure mathematics nearly

all scientific research is now done by teams, and the spectrum of ability of teams' members can be very wide--and flat. Indeed one can hold a respected job and even make a worthwhile contribution to the world by having sufficient intelligence to do what one is told--and the devotion required to come to work on time and perform it honestly.

"Indeed, the relative security and stability of the research career are probably more attractive to mediocrities than the romance of enquiry to the brilliant ones."

The truth probably lies somewhere between these two extremes. Scientists are reasonably intelligent, but reasonable intelligence isn't in all that short supply. There are roughly 200,000 Ph.D.'s in the United States, with an average Intelligence Quotient for the group of 125. Twenty-five percent of this group--mostly physicists and mathematicians--have I.Q.'s of 135 or higher. These are reasonably impressive figures--at least as high as the average of any other vocation. But, there are about 100 million people in the United States old enough to have earned Ph.D.'s; 2.5 million of these have native abilities above the highest group of Ph.D.'s, some 6 million adults are as bright as the average Ph.D. So, while scientists are indeed an intellectual elite, they aren't all that elite.

The scientist and his literature

People, scientists or not, want love, sex, power, prestige, freedom and money, in various proportions depending on the person. Scientists (and artists) typically put more emphasis on prestige and freedom than other people do. This emphasis on prestige starts early in a scientist's career. As Lawrence Kubie has written (American Scientist 42, 104-112 (1954):

"The intellectually gifted child is likely to turn away from athletics and the social life which he finds difficult to more bookish activities...If success rewards his consolatory scholarly efforts during adolescence, he may in later years tend to cultivate intellectual activity exclusively...As a result, by the time adult life is reached his only triumphs and gratifications will have been won in the intellectual field, his range of skills will have become restricted, and the life of the mind will be almost the only outlet available. Because of the extra drain of the laboratory on the student's time, the young man who sets out to become a scientist spends his adolescence putting every emotional egg in the intellectual basket than is true for most other young intellectuals. By such steps as these, the sense of security and the self--esteem of the young intellectual come to stand on one leg, so that when research is begun he invests in it a lifetime of pent-up cravings...it is inevitable that

scientific research will be supercharged with many irrelevant and unfulfilled emotional needs; so that the lifework of the young scientist tends to express both the conscious levels of his intellectual aspirations and his unfulfilled intellectual needs and unconscious conflicts."

Unfortunately for outsiders who try to intervene in the family quarrels, chief among the scientist's emotional outlets is his lifelong love-hate affair with the scientific literature. There are, for all practical purposes, three things you can do with the scientific literature: you can write it, you can read it, you can put it in piles.

Putting it in piles is one of the few places where the value structures of the scientist and the librarian conflict, as can be attested to by anyone who has ever overheard a conversation between a librarian who wants a book back, and a scientist who wants it on permanent loan:

"I've got to have this book. Who wants it? Him! What's he going to do with it? He can't read it. I'm the only man in the place who can understand it."

Librarians (and wives) just don't seem to understand that one's books and journals must be kept within arm's reach; that the inverse-square law (the strength falls off as the square of the distance

between the source and the target) also applies to the talismanic psychic aura of well-being given off by the scientific literature or, for that matter, that this aura can diffuse through the covers of unopened books and unwrapped journals!

Keeping the literature in piles is perhaps just another example of the standard desultory warfare between the sexes. Writing the literature is where the real emotional involvement lies. The young scientist learns, as part of the formal code of behavior of the scientist, that publication of the results of his research in a standard, authorized, refereed scientific journal is not merely right and proper, but a high duty and a behavior expected by his peers and employers. He learns informally that promotion comes about through visibility and that, at least up to a certain critical point in his career, visibility comes about through publication. He learns that there are "good" journals, and others not as good, but that every manuscript can eventually find a home somewhere and that, for all the platitudes about refraining from unnecessary publication, this must apply to someone else--it is better to publish something in anything, even if only a government report, than not to publish at all.

And, after a fashion, he is taught that there is a literature which can even, in desperation, be read. It is good for the young

to make them suffer, and one of the standard ways of making them suffer is to force them to spend time in the library, which is cheap, rather than at the laboratory bench, which is expensive. The young scientist is taught, well if he is a chemist, very well if he is a taxonomist or a systematic botanist, poorly in most other fields of science, and not at all in engineering that there is more to the world of science than is contained in his textbooks, that there is something called "the scientific literature" and that "consulting the literature" is a Good Thing to do. He may even be told that this literature lives in libraries and, in a few very advanced departments of chemistry, be taught how to use a library after a fashion.

He is not always told why this is a Good Thing to do. Scientific phenomena can be divided, very loosely indeed, into two main classes: those which are reproducible and those which are irreproducible. The determinations of the atomic weights of the elements, for example, are presumably highly reproducible phenomena; the report of a nova in 2,000 B.C., by a Chinese astronomer or the eruption of Krakatoa, or for that matter the occurrence of a crested titwillow 200 miles further north than the species has ever been observed before are highly irreproducible.

If our civilization and its archives were to disappear overnight,

the survivors might, eventually, be able to write a new edition of "The International Critical Tables" as told for example in "A Canticle for Leibowitz" (Walter M Miller, Jr. Bantam edition, 1961, Lippincott edition 1959), but the observational sciences--biology, astronomy, geophysics, and much of medicine--could never be rebuilt.

To the extent then that a body of science relies upon its records of things that have happened once, or for the first time, as in biological taxonomy where preference is given to the citing of a first published description of a species or, as in the case of chemistry, where the crass commercial spectre of possible patent infringements lurks will that science rely on, and possibly even train its students to use, libraries.

Note that I said students, not practicing scientists. Study of the information practices of scientists has become a Good Thing. A summary of the several hundred papers published to date (in the author's "The zoo and the jungle--a comparison of the information practices of intelligence analysts and scientists". A paper not-presented at the Mitre sponsored and not-held Third Congress of the Information Sciences, November, 1966.) shows the following results:

Scientists would rather gossip than read. Oral/informal routes are the preferred method of gaining information. One of the favorite

places for doing this is at scientific meetings--not by listening to formal prepared papers but by shmoozing in the corridors.

If and when scientists do settle down to read, they would far rather read in their homes, their offices or their laboratories--anywhere but the library.

Scientists do, however, spend as much as 50 per cent of their time in various forms of information processing activity--reading, writing and talking.

The average American scientist reads English plus or minus half of another language. He is almost forced to use works published in other languages in translation; perhaps as a result, less than 2 per cent of the citations in his bibliographies will be to works published in languages other than English.

He prefers to maintain his own personal files of journal articles and reprints--with systems ranging from elaborate cross-indexing down to sedimentary deposit and simian search.

Unlike the historian, for whom microfilm is a working tool, the scientist uses microfilm and microfiche only in desperation, or until he can get his hands on a reader-printer.

The scientist gets most of his leads to the literature from gossip, hot tips from friends, and by scanning, not reading, from 5 to 10 journals. He tends to make little use of abstracting services.

The average scientist makes even less use of specialized information centers than he does libraries. In most cases he does not even know that they exist!

I have a hunch that the average practicing scientist makes no more than one elaborate, full-scale retrospective literature search a year, if that.

But what does it take to make the scientist use the library? I have already hinted that the scientist derives more spiritual well-being from one book on his shelves than from 10,000 on the library shelves. A small study we recently sponsored at Lehigh, which resulted in a master's thesis with the impressive title of "The application of psychometric techniques to determine the attitudes of individuals towards information seeking and the effect of the individual's organizational status on these attitudes." (Report No. 2 under an AFOSR grant, AFOSR-724-66 to Lehigh University, by Victor Rosenberg. July, 1966) asked 94 individuals to rank eight possible information gathering methods according to their preference. The author, Rosenberg, found that the ease of use of an information gathering method is more important than the amount of information expected for information gathering methods in industrial and governmental environments, regardless of the research orientation of the users. Specifically, he found that scientists would first prefer

to search their personal libraries; secondly to search in the same building, thirdly to visit a knowledgeable person nearby and only fourthly to consult a reference librarian. I must admit, though, that reference librarians did come out better than using a library not within their organization, telephoning a knowledgeable person, writing a letter or travelling more than 20 miles.

Perhaps the single most useful concession most libraries could make to mechanization would be to enlarge their parking spaces!

And what of the awesome moment when the customer does confront the Reference Librarian? This, after all, is why books have been bought and cataloged, and classified and indexed, and why the library is lying coiled like a great jungle beast ready to spring into service. We are told in the library literature that the "chief art of the reference librarian is the knack of divining what the customer really wants"; that "the hardest part of answering a reference question is frequently not so much finding the answer as finding out the question; we have learned papers on "Communication Barriers and the Reference Question" (Ellis Mount: Special Libraries, Oct 1966, pp 575-578) in which we are told that the humble inquirer lacks knowledge of the depth and

quality of the collection, of the reference tools available, of the vocabulary used by a particular set of tools; that the inquirer does not willingly reveal his reason for needing the information; that the inquirer hasn't decided what he really wants; that he is not at ease in asking his question; that he feels that he cannot reveal the true question because it is of a sensitive nature and, the unkindest cut of all, that the inquirer lacks confidence in the ability of the reference staff!

This may all be very well and true of the average patron of the average reference desk of the average public library. It may even be more true of scientists than they would be willing to admit in public. I suspect though that the average scientist, upon being told that he would have to be psychoanalyzed by a reference librarian before he could get a book would answer, in the spirit of this Christmas season, "Bah! Humbug!"

The first lecture of the standard course in Bibliotaphy I (the hiding away of books, as in a tomb) is to make the customer look for the librarian instead of the book. And this is the last thing that the scientist-customer wants. He wants the library to provide a copy of a book that he knows exists (even if he happens to have the title, author and publisher all wrong). His first use of the card catalog is to ask it to tell him the physical

location of a known item, which had better be on the shelves so that he can take it out! All he really asks of the subject catalog is that it aim him towards the general section of the stacks where the books he is interested in may be found. And, if he's interested in a cross-disciplinary subject, he doesn't really care how many different shelf numbers the classification schedules say the books should bear--he wants all the books on his subject together in one section of the stacks. Moreover, on the rare occasions when he actually does a subject search, he certainly doesn't want to delegate this to anybody else. This is something which he must do himself, preferably in the privacy of his office.

I'm not saying that these creatures couldn't be library broken, if caught young and raised in a suitable atmosphere, but coming between a full-grown, adult scientist and the book he wants is at least as risky as coming between a mother bear and its cubs.

And, as I have written elsewhere ("With Forks and Hope-- Information Technology and the Information Sciences" in Kent and Taulbee, Electronic information handling, pp 277-292. Spartan, Washington, 1965):

"Ranganathan can talk of 'Every reader his book'; Time can talk of 'Every non-reader his non-book.'" (Librarians) must deal with carnivores, who want only small amounts of highly concentrated

information, and turn savage, if not cannibalistic when they don't get it; with placid herbivores, who are willing to munch vast heaps of cellulose to extract a minimum of nutrition; and, with the vast run of omnivores who, in spite of their innate ability to digest almost everything, have developed sophisticated, jaded, or even perverted appetites."

I am not at all sure what library automation can do for the scientist user. Presumably books can be put where he can get at them a little more expeditiously. It's no great problem to give him his own computer-printed book-catalog and personalized accession lists. Perhaps, some day, instead of not learning how to use the card catalog he can not learn how to use a computer console. If you want to believe the American Library Association (in RADC-TDR-62-614, "The library and information networks of the future." Prepared for Rome Air Development Center by the American Library Association under contract AF-30(602)-2578. April, 1963) in only thirty-three short years we will have a "worldwide network of optical speedcomputers transmitting instantaneous information in any form and in any language to any requesting user of the system" who will not even have to leave his home to sit in front of a multi-channel console with input/output channels for audio, video, image reproduction, instantaneous language translation, and even filters indicating whether or not a given request represents

a logical possibility!

I do not boggle at such magnificent concepts, even though I am never quite sure whether I am reading them as a connoisseur of information science or science fiction. But my hackles rise when it is proposed to replace the printed book as we know it with something printed on a toilet roll of scrofulous grey paper in blunt type, or flickering on a video screen or when I read, in "Libraries of the Future" (J.C.R. Licklider, MIT Press, Cambridge, Mass. 1965)"

"Surely, however, the difficulty of separating the information in books from the pages (!), and the absence, in books of active processors (termites?), are the roots of the most serious shortcomings of our present system for interacting with the body of recorded knowledge. We need to substitute for the book a device that will make it easy to transmit information without transporting material, and that will not only present information to people but also process it for them, following procedures they specify, apply, monitor, and, if necessary, revise and reapply."

I would hate to give up my life-long love affair with books and my hard-earned skills in dealing with them for this mess of potlatch. I like books. I like to read them, to make them, to have them around. I know of no electronic book substitutes that

I can carry in my briefcase, read on airplanes, or in strange hotel rooms or a camping trip or my own bathroom or, for that matter, prop up on the fender of my sports car while I tune the engine. I know of no form of electronic storage which can last for hundreds of years and still be read, that can, as Roderick Haig-Brown once pointed out, line my living room walls with the equivalent insulating value of 16 inches of brick, and still be ornamental, that will let me use it when and where I want to, which can be given each Christmas to my nephews and nieces, which is fun to hold and handle or throw across the room.

And, as I like books, I like libraries; shiny suburban supermarket libraries, dusty cluttered village libraries; patinous university libraries, the lean hard libraries of research establishments, the musty libraries of India with their teakwood cases, the vast rotunda of the reading room in the British Museum. I like the expectant, Christmas morning feeling of walking into a library and seeing what they have on their New Book shelves, or in a section of the stacks I haven't explored. I even, when they don't get between me and the books I want to take home, like librarians.

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13. ABSTRACT <p>The author proves to his own satisfaction that this is indeed a scientific age, not for its cultural impact but its nuisance value. He then contrasts the popular image of scientists with drab reality, enlivened only by the scientists' love-hate relationship with his "literature", whether it be read, written or kept in piles, even the latter function being undelegatable. A cursory summary of scientists' of the literature in general and libraries in particular is followed by pronouncing anathema on those who would substitute a toilet roll of printout for books as we know them and an unabashed paean of praise for books, libraries and librarians.</p>			

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